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EXAMINER	
WERNER, DAVID N	
ART UNIT	**PAPER NUMBER**
2112	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/726,521	LEE, YOUNG-HO
	Examiner	Art Unit
	David N. Werner	2112

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12-2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Drawings

1. The drawings are objected to because they do not accurately convey the material disclosed in the specification. Figure 5 shows vertical motion vector calculation part 200 as taking input from first frame 110 only. However, paragraph 34 of the specification states "The vertical motion vector calculation part 200 calculates vertical motion vectors from a first frame 110 and a second frame 120". Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and

informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 8 and 11 are rejected under 35 USC 103(a) as being unpatentable in view of U.S. Patent 6,072,833, "Apparatus and Method for Detecting Motion Vectors of Pixel Blocks of a Digitized Video Signal" (Yamauchi).

Claim 8 of the invention discloses a method for estimating motion vectors between two frames of a digital video. A motion vector is a representation of the distance and direction traveled by a pixel or group of pixels between two frames, and their calculation is a fundamental technique of video compression. The method in claim 8 specifies three steps. First, the vertical motion vectors of each pixel are generated. These vertical motion vectors represent how far a pixel moves up or down in the transition between successive frames. Second, the vertical reference positions for the horizontal motion vectors are deduced from the vertical motion vectors. These vertical reference positions serve will serve as the starting points for each pixel when their horizontal motion vectors are calculated. Third, the horizontal motion vectors are calculated from the vertical reference positions. In other words, the motion of each pixel

is determined by calculating the change of its vertical position, then its horizontal motion.

Claim 11 discloses an apparatus for obtaining motion vectors between two frames of a digital video. First, a vertical motion calculator determines the vertical motion vectors of a second frame, relative to a first frame, and second, a horizontal motion calculator that determines the horizontal motion vectors of the second frame, relative to the vertical motion vectors already determined.

Yamauchi teaches a system for detecting motion vectors. Figure 6 of Yamauchi shows its method: generating a "true motion vector" of a block of pixels as the sum of an "intial *[sic]* vector" and a "motion shift vector". Lines 28 through 52 of column 5 of Yamauchi discuss potential locations for initial vectors of a pixel block for embodiments of its invention, including blocks "immediately above" or "immediately below" a selected block. The third embodiment of Yamauchi, described in column 7, line 66 through column 10, line 23, and shown on figure 9, for example, has a limited selection of seven kinds of initial vector blocks. In this embodiment, the "luminance signal", a signal representing the values of the pixels of the two frames are inputted into an initial vector selector, a prospective initial vector generator, and a shift vector selector. The prospective initial vector generator generates possible independent motion vectors. The initial vector selector then determines the best initial vectors, based on previous motion vectors already stored in a memory, and the potential vectors determined by the prospective initial vector generator. The shift vector selector then chooses the shift vectors based on the pixel values of the two frames and the initial vector generated by

its corresponding component. The initial and shift vectors are then added together to produce true motion vectors, which are set as the output, and stored in the memory.

Yamauchi does not explicitly demonstrate an embodiment in which only pixel blocks directly above or directly below a selected block are used for an initial vector search, or that horizontal motion vectors are used as shift vectors. However, this reference shows that the strategy of narrowing initial vector searches to those in a small range was present at the time of the invention. Another embodiment of Yamauchi, described in column 6, line 54 to column 7, line 65, and shown in figure 8, uses the results of an initial motion vector search to determine vertical motion vectors. Yamauchi cites that this process improves accuracy in motion vector estimation, especially with interlaced signals. If vertical motion vectors can be used as "initial vectors", then horizontal motion vectors, in turn, can then be used as "shift vectors", and their addition would produce the "true motion vector". Therefore, claims 8 and 11 would have been *prima facie* obvious to one having ordinary skill of the art at the time the invention was made.

4. Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the publication by Hsieh, Chaur-Heh, and Lin, Ting-Pang, "VLSI Architecture for Block-Matching Motion Estimation Algorithm", on 06-1992, in *IEEE Transactions on Circuits and Systems for Video Technology*, Volume 2, Number 2, pp. 169-175 (Hsieh et al.), in view of Yamauchi.

The present invention is a system for implementing a specific type of the Block Matching Algorithm (BMA) of a digital video. The BMA is a well-known technique for

estimating motion vectors of a video, and is useful in compression. The invention combines the BMA technique with a system of estimating motion vectors as the sums of vertical motion vectors and horizontal motion vectors. Independent vertical motion vectors are calculated first, creating a series of offset vertical reference positions; these reference positions are then used to generate dependent horizontal motion vectors. Machine claim 1 of the invention discloses a machine for estimating the motion vectors between two frames of a video sequence. A motion vector is the distance and direction that a pixel or block of pixels moves between two frames. This motion vector apparatus has three components: first, a vertical motion calculator that determines the vertical motion of the pixels; second, an offset control that selects the vertical displacement of the rows of pixels in the first frame according to the vertical motion calculated, and third, a horizontal motion calculator that determines the horizontal motion of the pixels, using the calculated vertical motion vectors as starting points.

Claim 2 depends on claim 1, further limiting that the vertical motion calculator comprises a component that adds the "values" of the pixels in each horizontal row of the two frames and stores these row sums, and an "SAD value calculator" that determines the absolute values of the differences between every row sum of the first frame and every row sum of the second frame, and uses these results to generate sums of absolute difference (SAD) values. Claim 3 depends on claim 2, disclosing that the vertical SAD calculator comprises an adder that adds the differences between each row sum of the first frame and each row sum of the second frame, and a vertical motion

vector selecting unit that calculates the absolute values of these differences, and determines the lowest absolute value differences as the vertical motion vectors.

Claim 4 depends on claim 3, disclosing the functionality of the vertical SAD calculator. The calculator determines the SAD values using the formula

$V(u) = \sum_{i=sr}^{M-sr} \left| \sum_{j=0}^{N-1} Vp(i+u, j) - Vn(i, j) \right|$, in which V(u) is an SAD value, M is the number of pixels in the row of a frame, N is the number of pixels in the column of a frame, sr represents the search range, (i,j) are the coordinates of a pixel in the frame, u is the amount of horizontal motion, and Vp and Vn are the values in a pixel in the first and second frames.

Claim 5 depends on claim 2, further limiting that the horizontal motion calculator comprises a component that adds the values of the pixels in each vertical column of the two frames and stores these column sums, and a horizontal SAD value calculator that determines the absolute values of the differences between every column sum of the first frame–offset by the already-generated vertical motion vectors–and every column sum of the second frame, and uses these results to generate SAD values. Claim 6 depends on claim 5, disclosing that the horizontal SAD calculator comprises an adder that adds the differences between each column sum of the first frame and each column sum of the second frame, and a horizontal motion vector unit that calculates the absolute value difference between these differences, and determines the lowest absolute value differences as the horizontal motion vectors, with respect to the vertical reference positions determined by the offset control mentioned in the first claim.

Claim 7 depends on claim 6, disclosing the functionality of the horizontal SAD calculator. The calculator determines the SAD values using the formula $H(v)=\sum_{j=sr}^{N-sr}\left|\sum_{i=0}^{M-1}Vp(i+mv,j+v)-Vn(i+mv,j)\right|$, in which H(v) is an SAD value, M is the number of pixels in the row of a frame, N is the number of pixels in the column of a frame, sr represents the search range, (i,j) are the coordinates of a pixel in the frame, mv is the already-calculated vertical motion vector, v is the vertical offset position of a pixel, and Vp and Vn are the values in a pixel in the first and second frames.

Method claim 8 was discussed in section 3 of this office action; claims 9 and 10 are dependent. Claim 9 limits claim 8 such that the method of calculating vertical motion vectors involves adding the values the pixels of each horizontal row of a first frame, storing these vertical sums as a data structure, finding the difference between the vertical sums of the first frame and the second frame, and using these differences to generate SAD values. Claim 10 discloses a limitation of claim 8 in which the method of calculating vertical motion vectors involves determining and storing horizontal sums of the first frame, finding the difference between the horizontal sums of the first frame offset according to the vertical reference positions mentioned in claim 8 and the horizontal sums of the second frame, and using these differences to generate SAD values.

The examination of these claims in light of Hsieh et al. will start with the method claims 8-10. Section I of Hsieh et al. teaches the Block-Matching Algorithm (BMA), a method for estimating motion vectors by dividing a first frame into blocks of pixels of size n by n, comparing each block to the corresponding blocks in the second frame, and

generating motion vectors by determining the best match of the blocks between the two frames, using SAD values (or Mean Absolute Difference (MAD) values, as they are referred to in Hsieh et al). Specifically, the motion vector for a particular block is determined as "the least MAD(u,v) for all possible displacements (u,v) within a search area". As claim 9 limits the present invention to "values of pixels" instead of blocks of indeterminate size, simply let n = 1, or limit block size to 1 by 1 pixels. The present invention discloses two instances of calculating SAD values: the first, in which the search range is limited to one vertical line in two frames of a digital video sequence, and the second, in which the search range is limited to one horizontal line between the two frames, in accordance with the vertical reference positions of the first frame. The generation of SAD values from stored sums of pixel values is indirectly taught in functional language of the apparatus disclosed in Hsieh et al; sections II and III teach that pixel data is shifted into absolute difference calculating components. Therefore, Hsieh et al teach the limitations of claims 8-10, in which motion vectors between two frames of a digital video are generated from SAD values determined from the sums of pixel value data. However, this prior art does not teach the limitation that these motion vectors are calculated from component vertical and horizontal motion vectors.

In addition to the block motion algorithm described previously, Hsieh et al. primarily teaches a VLSI apparatus that implements said algorithm. This apparatus teaches specific limitations of claims 2-7. Recall that claims 2 and 5 each recite two limitations for motion vector calculation apparatus: "a...pixel value storage which adds values of pixels of each of...lines forming the first frame to calculate...sums, and stores

the...sums by...line", and "a...SAD value calculator which calculates SAD values from differences between the...sums of the first frame and the...sums of the second frame". Section III-B of Hsieh et al. discloses an array of processing elements, each containing a shift register, an absolute difference calculator, and an adder. The shift registers store the values of each pixel. The absolute difference calculator then calculates the absolute differences between the pixel values of the current (second) frame and the reference (first) frame. This absolute difference and the absolute difference of a neighboring pixel are summed in the adder and passed to the next processing element in the array. The complete array thus produces a series of sums of absolute differences. If this array is one-dimensional, instead of calculating the sums of absolute differences across the whole search region, a single row or column is searched, forming an SAD value of a single vertical or horizontal sum. This shows that Hsieh et al. teaches the limitations of claims 2 and 5.

Recall that claims 3 and 6 each teach two structural limitations on their corresponding SAD calculators: an adder that adds the differences between the sums of the two frames, and a motion vector selection unit that selects the least absolute value between the two frames as a motion vector. Section III-D of Hsieh et al. teaches a "Best Match-Selection Unit" that simply retains the least absolute difference in a register. Each calculated SAD value is compared with the current least SAD, and if smaller, becomes the new least SAD. These SAD values are inputted from a parallel adder that sums absolute differences between the current frame and a previous frame from each pixel. This corresponds with the calculation of the vertical sums and

horizontal sums in the present invention. So the two limitations of claims 3 and 6 are taught in Hsieh et al.

Claims 4 and 7 each disclose the mathematical formula used by an SAD calculator. An SAD value is calculated as the sum across a search range of the absolute value of the motion of each pixel value in a region. In claim 4, the horizontal displacement of each pixel in a column is added, producing a vertical motion vector, and in claim 7, the vertical displacement of each pixel in an offset row is added, producing a horizontal motion vector. These component SAD calculations are merely special cases of the general formula taught in section I of Hsieh et al:

$MAD(u,v) = \sum_{i=1}^{n}\sum_{j=1}^{n}|S(i+u, j+v) - R(i,j)|$, $-p \le (u,v) \le p$, where MAD(u,v) is the SAD value of motion vector (u,v), (i,j) is the location of a pixel block, S is the value of the block at (i+u,j+v) in the current, or second frame, and R is the value of the block at (i,j) in the reference, or first frame, and p defines the search range. In claim 4, v is set to zero, and in claim 7, u is set to zero, creating the formulae disclosed in the claims.

This completes the demonstration that the apparatus of claims 2-7 and method of claims 9-10 perform an implementation of the block motion algorithm, as shown in the prior art. However, Hsieh et al teaches a system that does not break down motion vectors into independent vertical motion vectors and horizontal motion vectors dependent on vertical reference positions. Therefore, additional prior art is required to show that every limitation of these claims is taught.

Yamauchi, as shown in section 3 of this office action, teaches a motion vector estimation system in which a shift vector is determined by an initial vector. The initial

vector and shift vector are then added to produce a final motion vector. One of ordinary skill in the art would appreciate that a vertical motion vector such as the one calculated in claims 2-4 and 9 in the present invention can be used as said initial vector. Likewise, a horizontal motion vector such as the one generated by a corresponding vertical motion vector calculated in claims 5-7 and 10 in the present invention can be used as said shift vector. Therefore, the use of the two specific motion vectors disclosed in the present invention as a species of the genus of motion vectors disclosed in Yamauchi would have been obvious to one of ordinary skill in the art at the time the invention was made. Then, as every dependent claim of claim 1 is taught by the combined teachings of the prior art, claim 1 is considered obvious, as it has limitations that were shown to be obvious. In the same manner, as the dependent claims of claim 8 are taught by the combined teachings of the prior art, claim 8 is too considered obvious.

Motion vector estimation is a specialized search function; the goal is to find a known pixel or block of pixels in a frame. It is a basic and general principle of computer science that a search is inherently made faster by reducing the number of items to search, or the range of a search. Then, a person having ordinary skill in the art at the time of invention would immediately recognize that by limiting the initial motion vectors described in Yamauchi to those directly above or directly below a given pixel, as described in section 3 of this office action, the initial search range for a potential motion vector of said pixel is reduced from the whole frame to one vertical line in the frame. This process has a linear order of growth. In contrast, a conventional bidirectional search, in which the initial search range for a potential motion vector is the entire frame,

has a quadratic order of growth, meaning it becomes mathematically fundamentally slower at a faster rate than a linear-growth process as the number of pixels in a frame becomes large, all other factors being equal. Then, by using well-known mathematical knowledge, a person having ordinary skill of the art at the time of the invention would have expect that by combining the block motion algorithm with a process that reduces search range, a faster motion vector search would result.

Therefore, as 1) there is a motivation to combine reference teachings; 2) there is a reasonable expectation of success by one having ordinary skill of the art at the time of the invention, and 3) the prior art references when combined teach or suggest all the claimed limitations, claims 1-10 are *prima facie* obvious.

5. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yamauchi in view of U.S. Patent 6,078,618, "Motion Vector Estimation System" (Yokoyama et al.). Yamauchi, as previously shown, teaches a system for detecting motion vectors in which a motion vector is represented as the sum of an independent "initial vector" and a dependent "shift vector". As already stated, a person having ordinary skill in the art at the time of the invention would recognize a vertical motion vector from the present invention as an initial vector, and a horizontal motion vector calculated based on results of the vertical motion vector calculation part as a shift vector. Yamauchi does not cover the limitation of an offset control part. However, lines 26-49 of the first column of Yokoyama et al. disclose that as of June 2000, a system with a "horizontal offset control section and vertical offset control section" "which will set new offset values for searching the next motion vector according to the output of the minimum value detection section"

is part of "a conventional motion vector estimation system". This means that it was known to a person having ordinary skill in the art to have knowledge of the use of vertical and horizontal offset controls in a motion vector estimation system at the time of invention. Thus, as every claimed limitation in claim 1, namely, a vertical motion calculation part, producing the "initial vector" of Yamauchi, a horizontal motional calculation part, producing the "shift vector" of Yamauchi, and an offset control part, disclosed as being known to one of the ordinary skill of the art by Yokoyama et al., are all taught in the prior art, claim 1 is *prima facie* obvious.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. U.S. Patent 5,832,101 (Hwang et al.) appears to be have been used in the specification of the present invention as representative of known art. U.S. Patent 4,355,306 (Mitchell) teaches a system using vertical correlation for compressing still images, particularly for text and facsimile applications. Japanese patent JP 01-166684-A (Tanaka et al.) is described in Yokoyama et al. as representative of known art. The publication by Do, Viet L. and Yun, Kenneth Y., "A Low Power VLSI Architecture for Full-Search Block-Matching Motion Estimation", on 08-1998, in *IEEE Transactions on Circuits and Systems for Video Technology*, Volume 8, Number 4, pp. 393-398, lists other modifications of the Full-Search Block Matching Algorithm.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David N. Werner whose telephone number is (571) 272-

9662. The examiner can normally be reached on Monday-Thursday from 7:30 AM – 5:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jeffrey Stucker can be reached on (571) 272-9821. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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